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Integrated Modular Avionics with COTS directed to Open Systems and Obsolescence Management

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1. SUMMARY

This paper describes how to design open computer systems for mission critical applications within the avionics of military aircraft using "Commercial Off The Shelf" (COTS) computer components[1]. Design aspects of "Integrated Modula Avionics" (IMA) are incorporated. How these aspects contribute to an effective obsolescence management is also described. The content of this paper is presented within the context of projects currently running at the European Aeronautic Defence and Space (EADS) Deutschland GmbH, Military Aircraft Business Unit (MABU), which are dealing with the subjects COTS and obsolescence.

First the primary design aspects of open computer systems will be discussed as well as internationally recognised associations and standards dealing with this topic. The potential behind the use of open computer systems for future avionics of military aircraft is to be unveiled.

It will be described, how to set up open computer systems, considering IMA conform design aspects, which fulfil the requirements directed to the equipment of mission critical avionics in military aircraft. Within this context the core aspects of IMA will be introduced and compared to conventional systems.

Regarding design aspects for open computer systems the design principals developed by the Allied Standard Avionics Architecture Council (ASAAC) have to be mentioned. Firms of the three participating countries - England, France and Germany – are co-operating to set up a European accepted standard for avionics HW and SW designed for use in military aircraft.

The use of COTS computer HW and SW will be presented as a cost effective solution for setting up open computer-systems for use in aircraft, until ASAAC conform HW and SW solutions are available. Possible COTS based configurations will be discussed referring to a current COTS computer system. This system is ruggedised for flight and built up with COTS HW and run by a COTS real time operating system. Successful flight-testing of the system has taken place.

Due to the rapid developing IT technology, today's computer systems quickly face obsolescence. Avionics for military aircraft are especially vulnerable because of the long development cycles. The opportunities of managing obsolescence, given by the use of COTS computer HW and SW, are identified with respect to future avionics of military aircraft. Affected qualification and flight-clearance aspects as well as the porting of avionics SW-applications, originally developed for proprietary computer systems, onto COTS computer systems will be mentioned.

2. OPEN SYSTEM ARCHITECTURES

The majority of computing systems in service in military aircraft of today, show a proprietary system architecture[2]. They are designed as Line Replaceable Units (LRUs) developed for special functions or cover a cluster of functions. Fitted together in the avionics of the EF2000, LRUs can be found for example as DASS computer, as navigation computer, as digital symbol generator etc. (Figure 1). Mostly HW and OS of these LRUs are invariant. Therefore modifications, as well as enhancements and technical innovations, that become necessary during the life cycle of a LRU, maybe can't be carried out. Any cross use of proprietary computer systems for different, mission-critical avionics functions may not be practicable due to their specific system design. Each function is implemented on a specially developed computer system, integrated as LRU in the aircraft avionics.

Today avionics systems of military aircraft, based on LRUs designed for special functions, represent a symbiosis of multiple LRUs. Thereby the high complexity of avionics systems, due to their comprehensive functionality, is further driven by the specific properties of the different LRUs - proprietary external HW interfaces, data-protocols etc.. Development, production, integration testing, logistics, maintenance and upgrading of today's avionics systems are therefore comprehensive and cost intensive over the whole lifecycle.

2.1 Main Design-Aspects

Pushed by the described deficits of current LRUs, open system architectures are required for future avionics of military aircraft. The core aspect of open systems is a flexible system design based on well established HW and

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[1] Thereby processor-boards, I/O-boards, chassis, operating systems etc. are referred to, which are available fully developed at the commercial market.

[2] Today's avionics computer already follow a modulare HW and SW design. However modules and components are coupled via supplier specific HW and SW interfaces.

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SW interfaces. By using open systems it is expected [1] to overcome the deficits of current LRUs:

- Avionics equipment following flexible HW and SW concepts shall support the use of state of the art technology.
- An open architecture can shorten equipment development and secure the upgrade potential needed.
- The scope of possible HW and SW solutions will grow.
- A well established upgrade potential and enhanced resource procurement shall help to reduce the pressing obsolescence risks encountered with current avionics equipment.
- Development, procurement and lifecycle costs can be significantly reduced.
- The integration of components into an equipment as well as the integration of equipment into an existing network, like the avionics of a military aircraft, shall be eased.
- The previously described scope of open system architectures is established via HW and SW offered in the commercial market.

Applied to computer systems for the avionics of military aircraft this implies the following focal aspects for an open system design [2] to be considered during the definition phase of a computer system:

- A modular system design with mechanical and electronic autonomous components[3], similar to that of modern LRUs, has to be followed.
- The integration of such components into a functioning system has to follow clearly defined, fully developed, commercially supported and therefore stable HW and SW interfaces. This refers to both external and internal HW and SW interfaces.
- HW and SW interfaces chosen for open system architectures have to be available to a broad clientele of users and should be continuously maintained and further developed by internationally recognised standardisation institutions.
- HW and SW interfaces suited for open computer systems have to support modifications and upgrades of existing and future avionics applications.
- The HW configuration of open computer systems must feature quick and easy maintenance and upgrade possibilities, e.g. well established interfaces, which guarantee the exchangeability of inoperative or obsolete components, boards and parts against state-of-the-art solutions. Within chassis spare slots must be available for the insertion of additional boards.

2.2 International Efforts

Efforts to establish open systems in military equipment find their origin in the USA. They were initiated by William Perry, 1994 Secretary of Defense and a strong advocate of an intensive usage of commercially established standards, specifications and state-of-the-art technology.

The same year Dr. Kaminski, Under Secretary of Defense for Acquisition & Technology, strengthened this direction when announcing, that new acquisitions of electronic equipment have to follow an open system architecture. To support this process he founded the Open Systems Joint Task Force (OS-JTF) and established it as an institution.

Due to this announcement of the Department of Defense (DoD) concerning military command, control, communications, computer and intelligence (C4I) systems, documents were set up, which describe definition, specification and development guidelines for open systems as well as the related HW and SW interfaces. Leading documents related to this topic are [3]:

- Joint Technical Architecture (JTA) framework
- Joint Aeronautical Commanders Group (JACG) guide specifications
- Generic Open Architecture (GOA) framework
- Technical Reference Codes (TRCs)
- Technical Architecture Framework for Information Management (TAFIM), cancelled in January 2000 and replaced by the current, equivalent JTA standards.

By the Institute of Electrical and Electronic Engineers (IEEE) open systems are defined via two basic standards:

- P1003.0/D15 Open Specification[4]
- P1003.0/D16 Open System Environment

These standards are accompanied by further IEEE standards.

2.3 Potential for Realisation

Open systems are principally suited for all kinds of avionics systems in military aircraft. Due to the strong adherence of open architectures to well established interfaces, avionics computer systems are especially suited for first introduction. HW and SW computer components have experienced a broad entry in many different industries. An intensive competition between the different suppliers of computer components has led to standardised HW and SW interfaces, which were quickly and widely accepted, e.g.:

- VME, PCI or cPCI are well established data-bus interfaces for coupling different computer components
- ATR is a standard for chassis, ruggedised for flight
- As standard format for the geometry of computer boards Eurocard is used
- POSIX is established as SW standard for application and user interfaces

Regarding this selection of standards already helps to fit together HW and SW components according to the principals of open system architectures, summarised by

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[3] Such components are designed as Embedded Systems, e.g. as SBC, combining dedicated equipment functions.

[4] "Public specifications that are maintained by an open, public consensus process to accommodate new technologies over time and that are consistent with international standards", Open Specification Definition IEEE P1003.0/D15..

the OS-JTF [1] in the Electronics Reference Model (Figure 2). A central design aspect of this model is a layered HW and SW architecture. The single layers of this model can communicate with each other via the SW and HW interfaces listed above. A computer system, based on the layered architecture of the Electronics Reference Model, is open for the exchange of single HW and SW computer components. This helps to reduce obsolescence risks associated with computer systems.

Computer HW and OSs, which satisfy the standards listed above and classified as ruggedised for flight, can be bought on the commercial market. Future aircraft programs as well as facing upgrades of aircraft in service may use existing COTS computer HW and SW to design open computer systems for use in military aircraft. Existing and newly developed avionics SW applications have then to be aligned to a layered architecture, described by the referred Electronics Reference Model.

A first approach will have to be restricted to mission critical computer systems to reduce the risk always associated with the introduction of new technologies.

3. KORRELATION WITH INTEGRATED MODULAR AVIONICS (IMA)

Design principals of open systems conform with the basic principals of Integrated Modular Avionics, although IMA goes much further.

Regarding the actual needs of aircraft operators IMA [4] propagates modular architectures for avionics systems. Intentions of IMA are:

- Improved maintenance of Avionics systems. Adaptations and enhancements during the lifecycle of avionics systems have to be simplified .
- To introduce a refined fault tolerance and fault management for avionics systems concerning detection, isolation and correction of in flight faults.
- To take advantage of shorter technology development cycles for avionics.

Applied to the HW of avionics computers IMA conform configurations will consist of components coupled via few dedicated HW and SW interfaces. These interfaces comply with international established standards. Within such computer systems, components can easily be exchanged and replaced by further or completely new developed components. Due to that, obsolescence risks are reduced. A further central design aspect derived from IMA is to build up component clusters within cabinets[5], which serve as data management centres. Step by step this development direction of avionics computers has then to be applied to further avionics systems. Therefore, in the future the design of military avionics will no longer be determined by multiple, separate computer systems or LRUs, coupled via data-busses and point-to-point connections. Consequently the diversity of electronic components in today's chassis respectively LRUs will be reduced. Instead common modules, components which are available in a few variants only, will handle different avionics functions. These common modules will be mounted in a small number of cabinets, connected via high speed data-busses, operating with a high bandwidth. In case of an in flight HW or SW failure, an in flight reconfiguration of the avionics system enables avionics functions to be maintained, depending on the severity of the failure that has occurred and the necessity of a function for save aircraft operation. Thereby a greater redundancy of avionics functions is reached with less components compared to the number of components needed for redundancy purposes in today's avionics systems.

Associated with avionics SW, IMA follows a strict subdivision. It distinguishes between SW applications for pure avionics functions, the OS and the driver SW for operating the HW components of an equipment. These three autonomous SW components are related via highly standardised SW interfaces and together make up the SW of an avionics equipment.

Avionics equipment following IMA design aspects shows a modular system architecture, based on few variants of common HW and SW components, which can be used for different avionics applications. The subdivision of the SW of an avionics equipment as well as the communication between the equipment's HW components via well established, highly standardised interfaces, e.g. VME, cPCI etc., lead to an equipment architecture, classified by SW and HW layers. These layers are again coupled via well established, highly standardised interfaces and make up the technical layout of modern IMA avionics equipment. Such a layered architecture corresponds with the Electronics Reference Model mentioned in Chapter 2.3 as an architecture for open systems. Therefore this model can be referred to as a development step for current avionics towards IMA.

Looking beyond the establishment of open systems, ASAAC is producing a set of IMA implementation standards. ASAAC is run by aerospace and IT companies in a tri national alliance between the participating countries England, France an Germany.

4. IMPLEMENTION GUIDELINES FOR OPEN SYSTEM ARCHITECTURES

Currently two different implementation concepts correlating with each other, ASAAC and COTS, are followed by EADS Deutschland GmbH to introduce open systems in military aircraft avionics. Both concepts follow different priorities and time scales. ASAAC is directed to the long-term and focused on a completely IMA reliant avionics in military aircraft. Until ASAAC conform HW and SW components are available, future configurations of avionics computer can make use of COTS. The focus of this concept is short-term, propagating a cost saving introduction of open systems in avionics, thereby contributing to the mitigation of the obsolescence risks related with current avionics systems.

[5] Contrary to chassis in service today, cabinets are part of the aircraft structure and represent mounting areas for a number of processor boards, I/O boards etc..

4.1 ASAAC

ASAAC is working towards the establishment and demonstration of standards for defining the architecture of modular avionics for military aircraft within the next four years. First ASAAC related HW and SW components shall be available on the commercial market in 2005. In a next step the ASAAC standards, agreed by the three European partner nations, shall become NATO standard (STANAG). Focal point of all ASAAC efforts towards modular avionics for military aircraft is a layered HW and SW architecture (Figure 3). Within ASAAC, the Electronics Reference Model, referred to in chapter 2.3 as layered architecture model for open system designs, is experiencing a refinement. The Application Layer (AL) is the upper layer of the ASAAC architecture model, containing all SW applications dealing with pure avionics functions as well as application dependent SW modules for data management and communication. Beneath the AL the Operating System Layer (OSL) is placed, comprising the operating system and general SW modules for system management and communication purposes. Within the ASAAC architecture model the Module Support Layer (MSL) is the lowest SW layer, closest to the HW. It is a cluster of HW related driver SW needed for operating the respective HW. AL, OSL and MSL are coupled via standardised interfaces - Application to Operating System Interface (APOS) and Module to Operating System Interface (MOS) - according to the ASAAC layered architecture model. APOS and MOS are defined with in the ASAAC standards.

System architectures, designed in layers according to the ASAAC model, imply a semi-automatic configuration of the HW and SW of an avionics system by system tables, so-called blueprints. In these Blueprints no unique HW and SW configuration is described but a variety of configurations, which cover possible in flight failures of single HW or SW components. After an in flight failure has occurred, an in flight reconfiguration[6] of the remaining HW and SW components maybe necessary. A semiautomatic writing of blueprints is supported by SW tools. Thereby system engineers are supported to develop different configurations for the HW and SW components of an avionics system with an affordable amount of effort. These configurations have to cover the failure free system status as well as possible failures of HW and SW components of an avionics system. During operation of an avionics system, the blueprints are loaded as data files in the HW components of an avionics system.

ASAAC therefore not only defines standards for the design of open system architectures for military aircraft avionics but also investigates SW tools for the realisation and implementation of ASAAC standards respectively IMA.

[6] After an in flight failure occurred, a reconfiguration becomes necessary, if avionics functions needed for aircraft operation are no longer available via the remaining HW and SW resources. If latter are not sufficient to offer all avionics functions of a fully operable avionics system, then avionics functions no longer needed for aircraft operation have to be shut down. The SW of avionics functions needed, then has to be newly distributed onto the remaining HW by a reconfiguration of the avionics system.

Until ASAAC conform HW and SW components are available, components offered on the COTS market are an adequate solution. Then already the next generation of computer systems for military aircraft can follow an open system design. Simultaneously, as discussed in chapter 5, obsolescence risks related with such computer systems are reduced.

4.2 COTS

EADS MABU has designed a Universal Aircraft Computer (UAC) based on COTS components as a short-term available computer system for mission critical military aircraft avionics, which has an open system architecture. The UAC is gaining increasing recognition for upgrade programs of in service military aircraft, the design of an avionics system for a new trainer aircraft and as an answer to the obsolescence problems encountered with current avionics of military aircraft. Further more severe cost restrictions and a shrinking procurement market for military ruggedised computer systems [5] are additional drivers for a lasting use of COTS components.

4.2.1 Central Design-Aspects of COTS Computer-Systems

The UAC is designed as a multiprocessor system for mission critical avionics applications. To fulfil this requirement, the basic version of the UAC design comprises a conduction cooled VME backplane fitted 1 ATR chassis, in which the following VME boards[7] are integrated:

- three PPC603e processor boards, two of them enhanced with MILbus1553B PCI mezzanine cards (PMC)
- one analog input board
- one graphic board

With the UAC a group of external electronic interfaces can be served:

- RS232
- Ethernet
- Discretes
- Analog Input
- RGB
- MILbus1553B
- ARINC429
- ATM
- Fibre Channel

These interfaces enable the UAC to be integrate into the avionics of military aircraft.

For operating the UAC, the commercially available realtime operating system LynxOS is used. Driver SW fitting with the chosen HW components is made available by the HW supplier for different operating systems. The operating system has to be configured according to the HW used. Since the operating system is fitted with a POSIX interface, UNIX compatible SW applications are supported on the UAC.

[7] To be integrated into the conduction cooled ATR chassis of the UAC, boards have to be fitted with wedge-locks compliant with IEEE 1101.2 for mechanical fixing.

The HW components used for the UAC have been specified by the supplier as ruggedised according to MIL-STD, concerning physicals loads the system will experience when operated in military aircraft. Therefore the HW can resist extreme temperature fluctuations, moisture, vibration, shock, EMC etc.. Supplier delivered CoCs grant, that the components are qualified for the relevant physical loads. Dependent on the CoCs is the licensing of the UAC for use in military aircraft.

The basic configuration of the UAC described above is only one possible configuration of the UAC. However the system architecture of the UAC is fixed, which means the UAC is a commercial VME based computer system housed in an ATR chassis. This chassis then is configured for a particular application by use of ruggedised Double-Eurocard[8] VME boards. Further the chosen chassis has to have spare slots, in case the integration of additional VME boards becomes necessary later on due to enhanced functional requirements. External interfaces of the UAC are selected according to the avionics system the UAC is planned to be integrated with. HW, OS and SW-drivers are procured via the COTS market. Although all HW components of the basic configuration of the UAC are offered by one supplier, a close coupling towards a single supplier has not taken place.

Like with proprietary computer systems, each intended UAC configuration has to be defined via requirements and a specification. Derivatives of already existing UAC configurations may then be described via amendments to existing documents. Therefore time savings related with the use of COTS components are mainly seen within the development phase of a computer system. If fully developed COTS components are deployed for the configuration of computer systems, a development phase as used for proprietary solutions will no longer be applicable. However, the definition and procurement phase can be barely shortened by the use of COTS. Nevertheless, the total time needed to configure a COTS computer system will be less than that needed for a proprietary solution. This implies cost savings parallel to the lower procurement costs of COTS components. How far LCC savings are possible with COTS solutions is part of an ongoing investigation.

4.2.2 Context to Open Systems

The UAC is built up from commercially available HW, OS and driver SW, coupled via well established HW and SW interfaces and follows a layered system architecture like that stated for open systems and ASAAC.

With VME as data-bus for inter-board communication and PCI as local data-bus for adding mezzanine cards to VME-boards, well established and therefore technical stable electronic interfaces have been chosen for the architecture of the UAC. The stability of these interface technologies becomes obvious regarding the broad variety of VME boards and PCI mezzanine cards offered by many COTS suppliers. American National Standards Institute (ANSI), IEEE and VMEbus International Trade Organisation (VITA), are all well known organisations for technical standardisation matters, that have maintained the VME- and PCI- standards. These interfaces, the geometry of the chassis and the mechanical board fixing guarantee the exchangeability of UAC components in the long-term. Enhancements of the UAC are supported by free VME slots on the VME backplane together with free PCI slots on integrated VME boards.

Know-how as well as experience concerning interfaces, HW, OS and driver SW of the UAC are absolutely necessary when using COTS components. Only then is it possible to take advantage of the modification and extension potential inherent to the open architecture of the UAC. Plug-and-Play features are commonly not supported by COTS components. This mainly depends on how strict COTS suppliers adhere to established interface standards in the design of their components. This is also a factor determining if COTS-components from different suppliers can be mixed, although they are classified as VME boards or PCI mezzanine cards.

The open aspect of the UAC architecture has been verified by using it in different projects with requirements that could not be fulfilled with the basic UAC configuration (Figure 4). Therefore the PPC603e board, which within the basic configuration is not fitted with a MILbus 1553B PCI mezzanine card, was replaced by a PPC750 processor board. Additionally a further PPC750 board was integrated into the ATR chassis. Furthermore a mass memory board was added to the configuration and the graphics board was removed. Only boards ruggedised for flight and delivered by the same supplier as the basic version of the UAC were used for these modifications. Within a another modification all three PPC603e boards are replaced by PPC750 boards provided by a different supplier. Since primarily designed for operation in an industrial environment, these boards additionally can be ruggedised for flight by the supplier, if this is a customer requirement. Two of these three PPC750 boards will be fitted with the MILbus mezzanine cards delivered by the supplier of the UAC basic version.

5. OBSOLESCENCE MANAGEMENT

Continuously shorter development cycles within the IT industry accelerates the obsolescence of IT products, with their life cycles getting shorter. Simultaneously this process is accompanied by shrinking government budgets for military expenses. Therefor an effective obsolescence management concerning the avionics of military aircraft is gaining lasting importance. Concerning avionics computers, different kinds of obsolescence risks have to be faced:

- Already when production of a proprietary avionics computer starts, some electronics parts needed may no longer be available, because they have become obsolete since the development phase of the computer has been completed.

[8] The geometric dimensions of double Eurocard boards are: 233.35 [mm] width * 160 [mm] height.

- The performance of aged proprietary computers may no longer be sufficient to serve the enhanced needs of today's avionics systems. Since the underlying technology of these systems has not been further developed, a system upgrade isn't possible.
- Components or parts necessary to repair inoperable computer systems have become obsolete and are no longer available via the respective market and spare stocks built up by the system operator have been used up.

Therefore in recent years international committees and industry have discussed possibilities for an effective obsolescence management regarding the avionics of military aircraft. Open computer systems based on COTS offer several approaches for an effective obsolescence management of military aircraft avionics, as discussed in the following chapters.

5.1 COTS Base

Computer components offered on the COTS market usually are available in the short-term. Therefore the mentioned obsolescence risk due to elapsed time between development phase and production start is not encountered with COTS. Obsolescence risks corresponding with an ageing computer system are mitigated by the common adherence of COTS components to commercially well established HW and SW interface standards. Because of competition COTS suppliers are strongly interested, that their components are compatible with such standards. To stay in business with traditional customers and to gain new customers, suppliers depend on the compatibility of their components with the products of other suppliers as well as the upward and downward compatibility of their own components.

5.2 Layered Model

SW applications, developed according to the layered ASAAC model, can be ported onto different HW configurations with a minimum amount of effort. Using the ASAAC standards allows for later enhancements and modifications of the SW application to be easy performed. Therefore a layered SW architecture, as propagated in the context of open systems, helps to reduce costs, time and effort caused by HW and SW obsolescence, thereby supporting an effective obsolescence management.

5.3 Running Upgrades

Computer systems, which experience short and regular upgrade cycles, will show only little obsolescence between two successive upgrades. As a result, upgrades as well as interim maintenance and repair efforts will be less complex and less costly. However if upgrades are widely spaced, a lasting obsolescence of computer systems is allowed. This will rise complexity and costs for upgrades, maintenance and repair. In the long-term, running upgrades will limit the obsolescence of computer systems, therefore being more affordable than widely spaced upgrades. Again the layered HW and SW architecture of open systems supports an effective obsolescence management when based on running upgrades.

5.4 Design of Avionics Systems by System Tables

A SW tool, which allows a semiautomatic system configuration by writing system Blueprint tables as introduced in chapter 4.1 ASAAC, can also be used for a more effective obsolescence management. However, obsolescence risks inherent to computer systems will not be mitigated. A respective SW tool simplifies the integration of HW and SW modifications, which have become necessary due to the obsolescence of a computer system. Developed for a better and easier design of complex avionics systems, such a tool also serves an effective obsolescence management.

5.5 Life Time Buy

If a COTS supplier intends to stop support and production of a certain computer component, which has become obsolete, he will probably offer his customers a Life Time Buy opportunity for this component [6]. Therefore computer systems based on COTS components enable a refinement of traditional obsolescence management strategies mainly relying on stock building. A customer will no longer be forced to determine and to buy the necessary amount of spares, to cover the whole life time of a computer system, which has just been put into service. He can determine the amount of spares needed for maintenance and repair when offered a Life Time Buy opportunity by the supplier, and thereby avoids a costly capital investment in stocks. Furthermore the inherent uncertainty about the amount of spares needed will have diminished at that time. This alternative is adequate for an effective obsolescence management, especially if it becomes obvious, that a COTS computer system despite his open architecture will experience no more upgrades till the end of his service life.

6. RESUME

COTS computer components, due to their alignment to commercially established international HW and SW interface standards, contain a lasting potential to introduce open computer systems into the avionics of military aircraft. At the same time these computer systems will be cheaper and better in performance then proprietary solutions. Generally even open COTS based computer systems will not fit Plug-and-Play design features. For the configuration of open computer systems based on COTS components comprehensive know-how is necessary about the HW and SW used, as well as about the porting of application SW on different HW platforms. Open, COTS based computer systems for the avionics of military aircraft are an effective approach towards IMA until ASAAC conform avionics equipment is available. The scope for an effective obsolescence management is already determined in the design phase of a system. Open COTS computer systems can help to make this scope given by current technology as big as possible. Finally however the actual market request for such systems will determine the success of this design approach.

7. ABBREVIATIONS

AL	Application Layer
ANSI	American National Standards Institute
API	Application Program Interface
APOS	Application to Operating System Interface
ASAAC	Allied Standard Avionics Architecture Council
ATR	Air Transport Rack
C4I	Command, Control, Communications, Computers and Intelligence
CoC	Certificate of Conformance
COTS	Commercial Off The Shelf
cPCI	Compact PCI
DASS	Defensive Aid Subsystem
DoD	Department of Defense
EMC	Electromagnetic Compatibility
GOA	Generic Open Architecture
HW	Hardware
IEEE	Institute of Electrical and Electronic Engineers
IMA	Integrated Modular Avionics
I/O	Input / Output
IT	Information Technology
JTA	Joint Technical Architecture
LCC	Life Cycle Costs
LRU	Line Replaceable Unit
MABU	Military Aircraft Business Unit
MOS	Module to Operating System Interface
MSL	Module Support Layer
OEM	Original Equipment Manufacturer
OS	Operating System
OS-JTF	Open Systems Joint Task Force
OSL	Operating System Layer
PCI	Peripheral Component Interconnect
PMC	PCI Mezzanine Card
POSIX	Portable Operating System Interface
PPC	Power Processor
SBC	Single Board Computer
STANAG	(NATO) Standardisation Agreements
SW	Software
TAFIM	Technical Architecture Framework for Information Management
UAC	Universal Aircraft Computer
VITA	VMEbus International Trade Organisation
VME	Versatile Module Europe

8. LITERATURE

[1] Open Systems Joint Task Force – Office of the Under Secretary of Defense (Acquisition & Technology), Open Systems Tutorial, October 1997

[2] US Air Force, Open Systems Implementation Guide, Version 2.0, August 1997

[3] United States Special Operations Command, Open Systems Development Plan, August 1996

[4] B. Balser, M. Förster, J.-P. Munk, Anwendung der Integrierten Modularen Avionik in militärischen Upgrade-Programmen, July 1999.

[5] Carbonell, J., Ostgaard, Impact of COTS on Military Avionics Architectures, AGARD CP-581/29, October 1996.

[6] COTS Journal, On the rugged Side: Sidebar, January/February 2000.

9. FIGURES

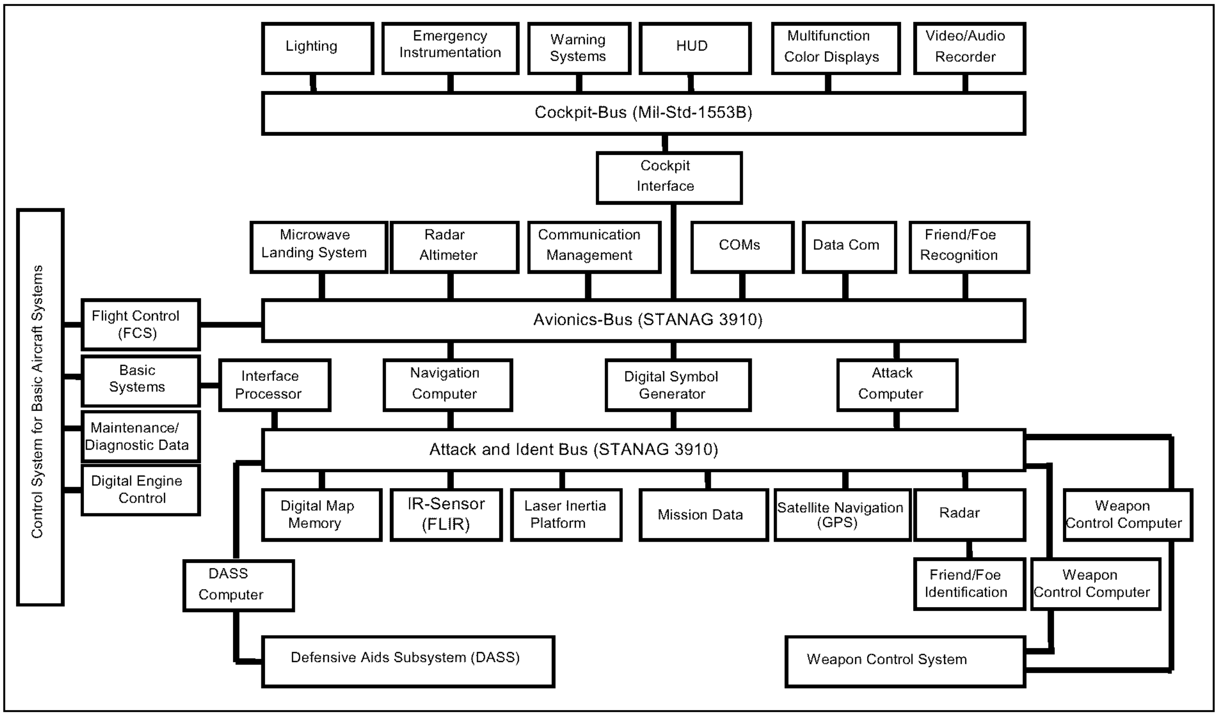
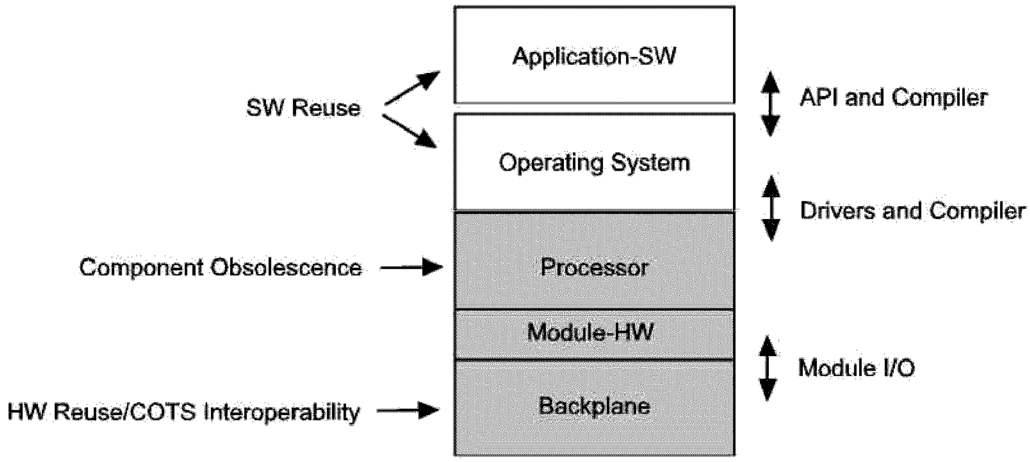


Figure 1: Avionics system EF2000



Identified open system interfaces:	
Language	ADA and C++
Application Program Interface	POSIX
Operating System	UNIX
Data Bus	VMEbus
Local Area Network	Ethernet

Figure 2: OS-JTF Electronics Reference Model

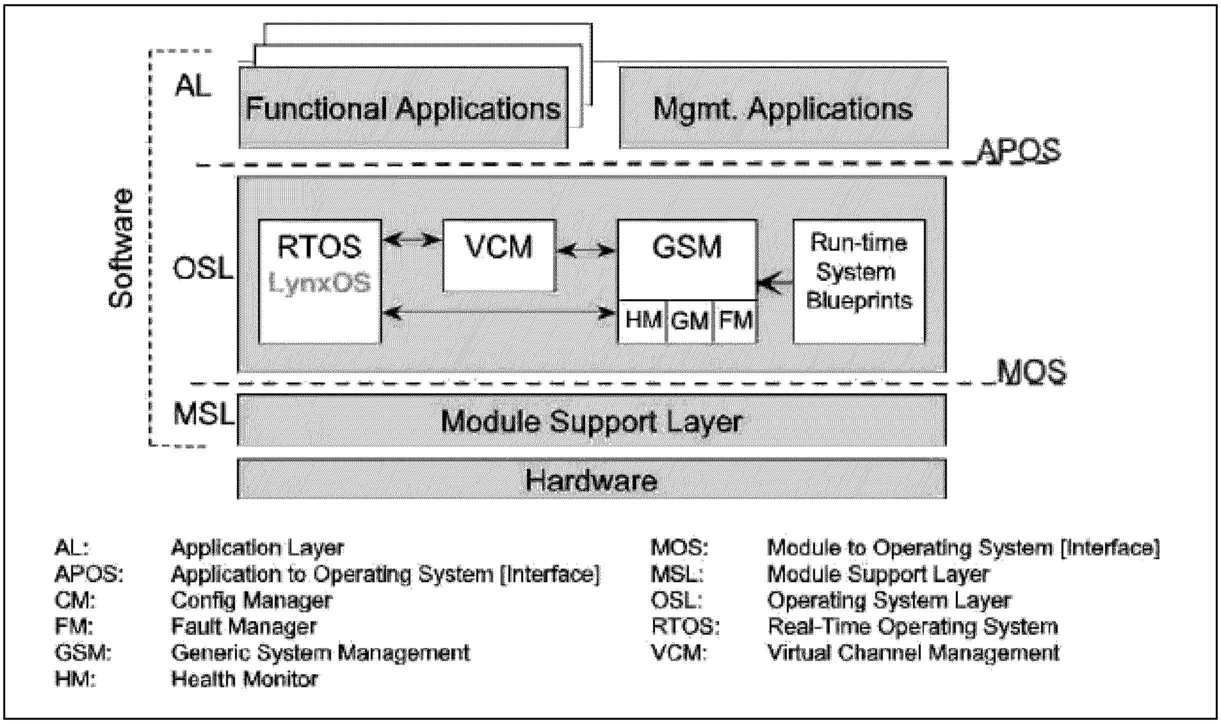


Figure 3: ASAAC model for layered system architectures

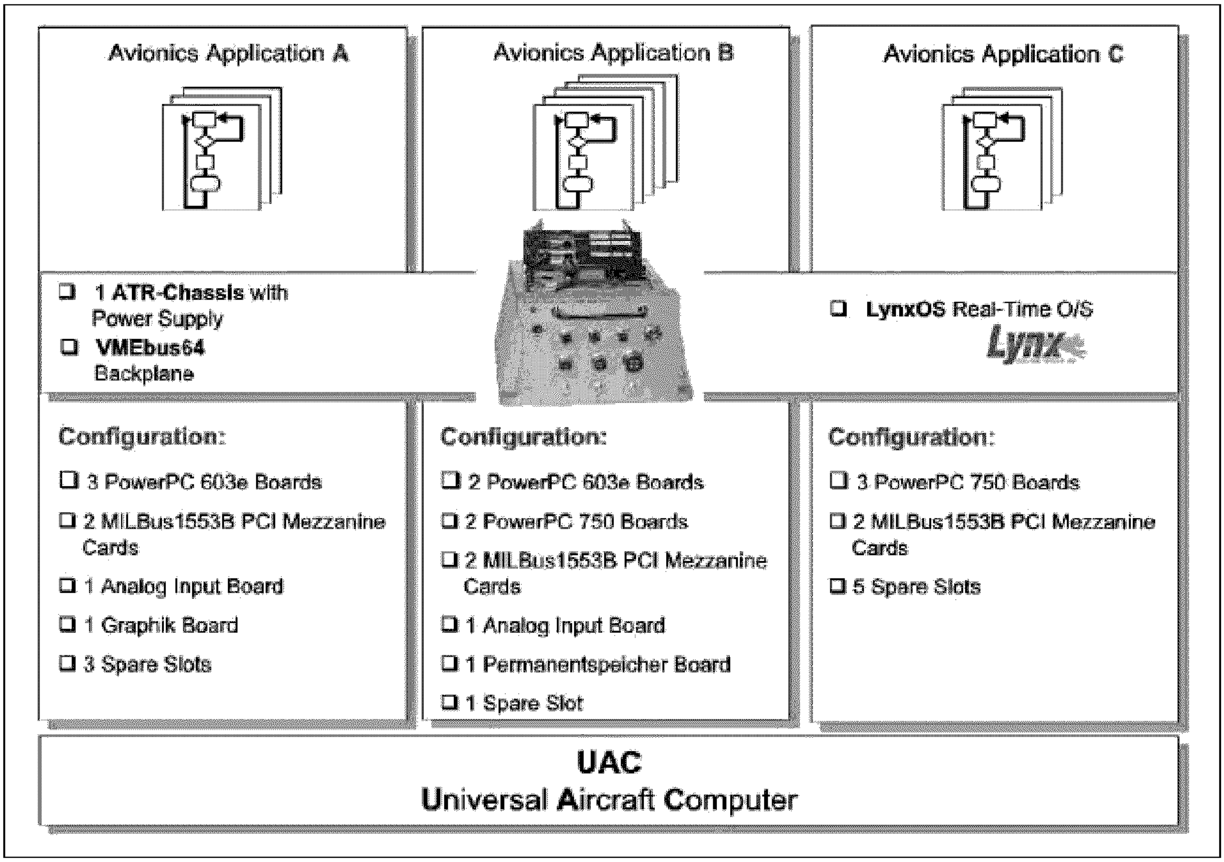


Figure 4: COTS Computer with an open system architecture

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